An Overview of Non-Invasive Procedures using Glucometer for Measuring Various Glucose Levels

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Abstract*— Glucometer is a medical device which measures the inexact deliberation of glucose in blood. Now-a-days the glucometer used go behind invasive procedure. Hence there is an insistent need to reinstate invasive procedure by non-invasive procedure. The proposed work is to testing the glucose series in saliva instead of puncturing the skin. The principle of intention behind the work is to establish electrochemical reactivity which helps to identify the blood glucose level of the patient. As the salivary glucose level is directly related to the blood glucose level, diagnosing the salivary glucose level blood glucose can also be established. The normal glucose range in saliva is 0.5 – 1.00 mg/100ml for the normal blood glucose range is 70 – 99 mg/dl. The average range of glucose in saliva is 1 mg/dl for blood glucose range 84.5mg/dl. So the value difference between blood glucose and salivary glucose is 83.75 mg/dl. Hence by deducing the salivary glucose value of the patient with the average blood glucose level or by adding the patient's salivary glucose value to 83.75, the patient's blood glucose value can be estimated. The strip consists of some lysis enzymes that can react with saliva. The reaction between enzymes and saliva form hydrogen peroxide (H_2O_2). The measurement of hydrogen peroxide relays the value of salivary glucose intensity. At this instant the salivary glucose level can be differentiated with typical blood glucose range and hence the blood glucose range of the patient can be deliberated. The device requires an electrode that can measure the hydrogen peroxide value by passing current. A suitable preamplifier is also required for input current amplification. Finally a digital display unit is used to dissect the values. This approach can also be used in real time processing of blood glucose non-invasively.

Keywords*— *Glycogenolysis, gluconeogeneis, glucosuria, Glycated Haemoglobin, Glycated Haemoglobin, Hemophobia

I. INTRODUCTION (NON INVASIVE GLUCOMETER)

Diabetes mellitus is metabolic disorder that is caused due to the malfunction of pancreas or due to improper utilization of insulin by body cells. Globally, 422 million adults were living with diabetes in 2014, when compared to 108 million in 1980. The global dominance (age-standardized) of diabetes has doubled while 1980, intensifying from 4.7% to 8.5% in the adult inhabitants. Diabetes caused 1.5 million deaths in 2012. The two types of diabetes are type Ⅰ diabetes and type Ⅱ diabetes. Type Ⅰ diabetes is caused by deficiency of insulin secretion, which is due to the crash of β-cells in islets of Langerhans of pancreas. Due to lack of insulin glucose cannot be absorbed by the cells. The factors for this disorder are family history, genetics, geography, age. In type Ⅱ diabetes pancreas emit adequate insulin but there is no proper protein biding spot in the cells for utilizing insulin. Insulin is the binding site for glucose. If insulin cannot pierce the cell means glycogenolysis and gluconeogeneis never happen, hence glucose also remains in the blood stream. This circulating glucose and insulin enters the kidney for filtration. Surplus of glucose makes the kidney to efforts more to filter glucose. So that too much of glucose released in the urine resulting from glucosuria. This condition is unfortunately a renal failure state. The factors for type Ⅱ diabetes are genes, extra weight, metabolic syndrome, too much glucose from liver, bad communication between cells, broken beta cells. More than 160,000 children and adolescents with type Ⅰ diabetes are enrolled in the United States. 374 million people are at increased risk of developing type Ⅱ diabetes. Approximately, saying that 463 million adults (20-79 years) were living with diabetes will rise to 700 million by 2045. Certain amount of insulin is injected to the patients constantly to deficit insulin disorder. Hence this serious disorder requires nonstop monitoring of glucose levels in blood. For severe risky patients, glucose must be monitored before and after eating. A glucometer is a medical device for determining the near concentration of glucose in the blood. But they follow only invasive procedure that is picking up

blood from body. This is very painful to patients. When invasive procedure is performed daily, that can irritate the person. Hence there is an urgent need to replace invasive procedure by non invasive procedure. There is a direct relationship between the salivary glucose and blood glucose levels. By establishing the proportionality constant helps us to identify the blood glucose levels.

II. LITERATURE REVIEW

Stages of development in blood glucose meter:

Ames reflectance meter which was developed by Tom Clemens in 1969. Meter allowed diabetic patients to watch blood glucose levels by themselves. Blue light was needle with needle and its intensity reflected was measured.

Reflomat (Boehringer. Mannheim) released the first portable blood sugar meter within the world which was designed for healthcare professionals once in 1974. It only requires a little blood.

In 1987, the first biosensor system was introduced to screen blood sugar which was launched by MediSense. An enzyme electrode strip was used which also requires blood.

As monitoring blood glucose needs long-term values of blood sugar, including quite 4 times a day. Another procedure for continuously monitoring glucose is Continuous Glucose Monitoring (CGM) can measure blood sugar continuously, which makes it very straightforward to examined and be inclined over the entire day. A sensor of CGM is typically inserted under the skin to watch the glucose at any time.

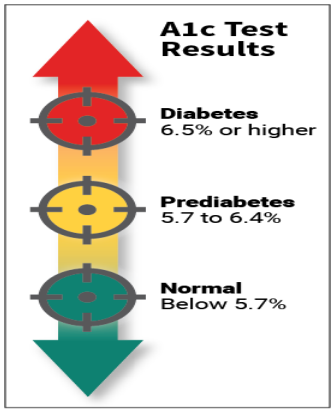
This often proceeds to see normal blood glucose range. It's very essential for monitoring, to diagnose with no side effects within the process.

TESTING MEASUREMENT

There are three types of testing blood glucose including

- Glycated Haemoglobin (HbA1c)
- Self-monitoring of blood glucose (SMBG)
- Ambulatory glucose profile (AGP).

HbA1c can reflect the typical of glucose level over the previous two to three months as the lifetime of RBC is 120 days. Hemoglobin is protein pigment that supply oxygen to the tissues. It also binds to sugar in the blood, and a substance called glycated haemoglobin or Hemoglobin A1C. The normal range of Hemoglobin A1C is 4% - 5.6% .The measurement of HbA1c doesn't need special preparation to check the glucose value at anytime of the day.



SMBG is that the self testing, the blood sugar level monitors anywhere anytime. Everyday 3 to 4 times, the glucose level is checked by them.

AGP is a single page, standardized statement for interpreting a patient's every day glucose and insulin patterns graphically or quantitatively.

The **CoG** device employs a singular mathematical approach to predict glucose concentrations supported multiple optical signals. The primary clinical results indicate that the device may show appropriate agreement with reference methods to be used for pain-free glucose assessment in daily routine.

A technique called ear piercing is independent of age, gender, body mass. Only an ear piece is required for glucose measurement.

In UV Spectrophotometer gives constant correlation between blood glucose and salivary glucose. Here the salivary glucose is compared to blood glucose in the dermis. There is a linear increment in glucose ranges of saliva and blood.

The three tests Dextrostix, BM test glycemie, and reflotest were conducted in the case of neonates and infants and readings were noted. Out of these three Dextrostrix tends to overestimation of glucose levels in neonates. Hence Dextrostrix fails to match the laboratory results which is less than 1.1 mmol/l(20 mg/100ml).

IR spectroscopy is used to detect glucose range. Here the amount of IR diffused reflectance spectra or bands of electromagnetic spectra are calculated. This can be influenced by the amount of oxygen saturated in the body.

In sweat based glucose analysis the body sweat is collected to react with glucose oxidase biosensor and that will make value.

COMPARISON OF TECNIQUES:

Most of the procedures mentioned above requires blood sample. Globally, there is no noninvasive glucometer in practice. However the recent researches are going on to develop a device non-invasively.

Glycated hemoglobin increases freely reactive radicals in blood cells. This causes to blood cell aggregation and augmented blood viscosity, resulting from impaired blood flow. Anemic peoples may be misleaded by this test. Other things that can affect the results of the hemoglobin A1c include supplements such as vitamins C and E and high cholesterol levels. Kidney disease and liver disease may also affect the test. Men have thicker skin than women. Therefore, ear piercing technique produces collagen-rich scar tissue that is denser than a regular tissue. Dextrostrix failed indicate the hypoglycemic conditions. The IR spectroscopy is failed to give accurate values. In IR spectroscopy method, the oxygen

amount is proportional to blood glucose level in every time. It may concern the age, body mass.

Salivary glucose is not affected by body mass and gender. Compared to other conventional non – invasive methods this method is very cost efficient. This also supposed to use like an SMBG devices. This can never cause any irritation to patients. Some may suffer from hemophobia. A physician cannot puncture their daily for blood samples. They may provide a great relief to such patients. This method does not require any pre-preparation. Sweat based glucose analysis is practically impossible and difficult too. Because the human body cannot produce sweat as per the required time.

OVERVIEW:

Non invasive glucometer is painless procedure for measuring blood glucose. The salivary glucose range is first determined. It is resolute by using a enzymatic strip. The strip contains enzymes that can kill other organic substances in the saliva other than glucose. For example, proteolytic enzymes causes lysis of proteins and lipolytic enzymes causes the lysis of lipids. The remaining glucose concentration in saliva can be calculated. Now the glucose in the saliva reacts with glucose oxidase (or dehydeogenase) and forms hydrogen peroxide (H_2O_2). The amount of hydrogen peroxide (H_2O_2) can be measure using a biosensor unit. This biosensor acts as a transducer here. The hydrogen peroxide (H_2O_2) quantity is measured because it is the direct measure of glucose amount in the saliva.

$$\text{Glucose} \xrightarrow{\text{glucose oxidase}} H_2O_2$$

Here some **electrochemical reactivity** takes place to produce small amount of current in the transducer.

Now this transducer current is taken for further intensification. The pre-amplifier may be used to amplify the transducer current output. Analog to Digital Converter (ADC) is used to get output in digital form. At this time the value is round-off using a quantizer.

The normal glucose range of saliva is 0.5 – 1.00 mg/100ml. The average glucose range of blood is 1 mg/dl. The normal value of blood glucose level is 70 – 110 mg/dl and its average is equal to 84.75 mg/dl. The difference in the average of salivary glucose and blood glucose is **83.75 mg/dl.**

Now the output from the quantizer is summed with the value **83.75** using a adder circuit. Now the output can be relayed to a display to get the glucose range. This method can show 90% of accuracy when compared to conventional invasive glucometers.

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